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Device for Enabling Vapour Emanation

Field of the Invention

This invention relates to a device that enables the emanation of a chemical formulation, such as an insecticide or a fragrance, into surrounding atmosphere. The invention also relates to a device that enables the emanation of a chemical formulation and is releasably insertable into an electrical heating apparatus used to vapourize the chemical formulation.

Background to the Invention

A number of patent documents disclose portable devices that enable the application of a herbicide or an insecticide, particularly for the purpose of killing weeds and the like. Such an example is disclosed in US Patent No 4,309,842 in which a portable hand-held herbicide and insecticide applicator comprises a tube 12 which acts as a handle and connected at one end of the handle is a pair of hollow prong sections. The prong sections together with the handle 12 form a liquid reservoir conduit for the pesticide or herbicide and extending between the ends of the prong sections is an absorptive rope mop which is saturated with the liquid pesticide or herbicide. The user then drags the device over weeds and the like such that the saturated rope mop comes into contact with the weeds and thereby eventually kills the weeds.

Other devices include sprayer systems that have a reservoir and use an electric motor, such as is disclosed in US Patent No 6,109,548. This sprayer system reduces the need to manually create pressure within a portable spray unit. A valve stem within the reservoir may be utilised by a user to connect a conventional air tank thereto for inserting high amounts of air pressure directly into the reservoir without requiring the use of a manual or electric pump. Where a power switch is closed the electric motor operates the air compressor whenever the air pressure within the reservoir drops below a predetermined level. A manual pump may be utilised when the electric pump fails or a battery connected to the electric motor becomes discharged.

Other systems involve the atomisation of liquids, such as is disclosed in US Patent No 4,356,528. This patent discloses an invention that utilises electrostatic spraying of liquid compositions, particularly over leaves of plants, by supplying a liquid to a spray orifice, which is preferably of capillary dimensions. The spray orifice preferably has a charged surface which is electrically conducting or semi-conducting and which is adjacent a field intensifying electrode, the arrangement being such that the liquid is drawn out primarily by electrostatic forces, atomised into electrically charged

particles and projected past the electrode. Thus the particles wrap around the leaves of the plants and coat both upper and lower surfaces of the leaves.

None of the above prior art systems provide a substantially low cost device that enables the discharge of a chemical formulation into surrounding atmosphere, particularly for the purpose of a personal insect repellent or in situations where a portable small apparatus may be used in a room which periodically enables the emanation or vapourization of the chemical formulation. The present invention provides a device, such as in the form of a cartridge, that fits into a recess of a portable apparatus that enables such a periodic discharge of a chemical formulation. It may be refilled or replaced completely when all the chemical formulation has been discharged. There is a need for such an apparatus that is substantially low cost to run, may be run on batteries or mains power and last a substantial length of time without having to replace batteries or provide a new or refilled reservoir of the chemical formulation.

The present invention has substantial advantages over the above mentioned applicators and sprayers and conventional aerosol sprayers as there is no need for the user to physically operate the device as it may be left in an area, as a portable unit or a fixed unit depending on the power supply, to automatically enable discharge of a chemical vapour into a surrounding atmosphere.

Some patents disclose the use of a cartridge insertable into a heating unit incorporating a wick in continuous contact with a chemical formulation. Examples include US patent numbers 5903710, 5976503 and 6123935. However in all these patents the heater element is in direct contact with the wick which has the disadvantage of excessive wear on the wick requiring replacement of the wick, and therefore the whole unit, after a number of uses. Furthermore in US patent number 6123935 there is no defined aperture through which vapourized chemical formulation is guided to the atmosphere. An end strip of the wick is exposed to the atmosphere from which the vapour escapes, leading to excessive formulation being used.

In US patent number 5945094, although a wick in contact with a chemical formulation is not in direct contact with a heater, it has the disadvantage of a separate wick and cartridge, the wick requiring the removal of an impermeable membrane to expose the wet wick area to the atmosphere prior to use. Furthermore it is not designed to fit a range of existing heater devices in a releasably insertable manner.

Further problems that the present invention seeks to overcome include providing an emanation device that is able to fit existing heater apparatus and can survive for lengthy periods at heater temperatures in excess of 130 degrees Celsius, survive prolonged contact with organic solvents and not stretch, warp or creep.

The present invention in a further embodiment provides such a device that is made from materials allowing a rigid laminated but flexible structure to releasably fit a wide range of existing heater devices. It also provides the advantages of thermal conduction via a part of the laminate structure for heat transfer to the wick. By fitting to existing heater devices, the present invention provides a cheaper option to users rather than having to buy a completely new device incorporating a heater unit.

Summary of the Invention

According to a first aspect of the invention there is provided a device for enabling a chemical formulation to be vapourized into an atmosphere comprising:

means for storing the chemical formulation;

wick means in continuous contact with the chemical formulation;

wick support means for supporting the wick means and having an aperture;

the wick means located within the wick support means;

means to locate the wick support means such that the aperture of the wick support means is co-located with a heater means;

wherein the wick means is wet by the chemical formulation and upon contact with the heater means vapourizes the chemical formulation through the aperture of the wick support means.

Preferably the wick support means is formed by a first portion and a second portion affixable to the first portion. The wick means may be located between the first portion and the second portion of the wick support means. The aperture may be located in the first portion of the wick support means. The location means preferably locates each of the first portion and the second portion of the wick support means such that the aperture of the first portion of the wick support means is co-located with the heater means.Preferably the storage means is located on the second portion or the first portion of the wick support means.

Preferably the wick means is substantially elongate having a first portion in continuous contact with the chemical formulation and a second portion in contact with the heater means. Preferably the heater means vapourizes the chemical formulation in the vicinity of the second portion of the wick means through the aperture of the first portion of the wick support means. Preferably the heater means is a microheater element and particularly an impedance means such as a resistor.

Preferably the second portion of the wick support means has an aperture co-located with the heater means to enable the chemical formulation to vapourize into the atmosphere through the aperture of the second portion of the wick support means.

Preferably the heater means has one or more pulses applied thereto in repeated fashion to provide heat in order to vapourize the chemical formulation.

Preferably the wick means has a resistance to flow of chemical formulation from the chemical formulation storage means sufficient to enable the second portion of the wick means to become wet after it has been dried by vapourization of the chemical formulation within a cycle of an applied pulse or pulses to the heater means.

Preferably the device is adapted to be received by portable apparatus having the heater means, where the heater means being supplied with power from a portable power supply, such as batteries. Alternatively, the device may be adapted to be received by apparatus having heater means being supplied with power from a fixed power supply, such as from a mains supply.

Preferably the location means is a pair of indentations, one on each side of the wick support means, that act in an interference fit with corresponding projections on the apparatus, which when engaged provide an indication to a user that the device is correctly located with respect to the apparatus. Preferably a tactile indication is provided to the user that the device is correctly located. Alternatively, the location means may be a pair of projections, one on each side of the wick support means, that act in an interference fit with corresponding indentations on the apparatus, which when engaged provide an indication to a user that the device is correctly located with respect to the apparatus.

According to a second aspect of the invention there is provided a device for enabling a chemical formulation to be vapourized into an atmosphere comprising:

means for storing the chemical formulation;

wick means in continuous contact with the chemical formulation;

wick support means for supporting the wick means and in contact with the wick means, the wick support means having an aperture;

wherein the wick means is wet by the chemical formulation and, upon application of heat from a heater means to the wick support means indirectly heats the wet wick means and thereby vapourizes the chemical formulation into the atmosphere through an exposed portion of the wick means and the aperture of the wick support means;

wherein further the device is releasably insertable into a heater unit having the heater means.

Preferably the exposed portion of the wick means is one end or one edge of the wick means.

According to a third aspect of the invention of the invention there is provided a device for enabling a chemical formulation to be vapourised into the atmosphere and releasably insertable into a heating unit, the device comprising:

means for storing the chemical formulation;

wick means for contacting the chemical formulation;

a housing enclosing a portion of the wick means adapted to engage and retain the device in the heater unit, the heater unit having a heater means; and

wick support means in contact with the wick means and proximal to the heater means when the device is inserted into the heater unit;

wherein the wick means is wet by the chemical formulation and is heated indirectly by the wick support means to vapourize the chemical formulation through an aperture of the housing into the atmosphere.

According to a fourth aspect of the invention there is provided a device for enabling a chemical formulation to be vapourized into the atmosphere comprising:

a substrate;

means for storing the chemical formulation;

wick means for contacting the chemical formulation;

a housing enclosing a portion of the wick means;

the wick means, housing and storage means in contact with the substrate and the wick means extending between the housing and the storage means;

wherein the device is releasably insertable into a heater unit having a heater means whereby the substrate is heated by the heater means and thereafter the wick means, wet by the chemical formulation, is heated to vapourize the chemical formulation through an aperture in the housing into the atmosphere.

According to a fifth aspect of the invention there is provided a method of constructing a device for enabling a chemical formulation to be vapourized into the atmosphere, the method comprising the steps of:

forming a substrate comprising a first layer made of a first material;

forming a storage means for the chemical formulation and made from a second material;

forming a housing made from the second material;

placing a wick means on the substrate; and

bonding the storage means and the housing to the substrate such that the wick means is partially enclosed by the housing and extends into the storage means to enable contact with the chemical formulation.

According to a sixth aspect of the invention there is provided a device for enabling a chemical formulation to be vapourized into the atmosphere comprising:

means for storing the chemical formulation;

wick means for contacting the chemical formulation;

wick support means in contact with the wick means and proximal to a heater means;

such that when the chemical formulation is not in direct contact with the wick means, due to the orientation of the heater means, the chemical formulation moves along a side of the storage means by capillary action until the chemical formulation reaches the wick means in contact with the storage means, thereby wetting the wick means;

whereupon the wick means is heated indirectly by the wick support means to vapourize the chemical formulation into the atmosphere.

According to a seventh aspect of the invention there is provided a device for enabling a chemical formulation to be vapourized into the atmosphere comprising:

means for storing the chemical formulation;

wick means for contacting the chemical formulation;

wick support means in contact with the wick means and proximal to a heater means;

such that the wick means extends along an edge joining the storage means and the wick support means whereby the chemical formulation moves along the wick means by capillary action until the chemical formulation reaches an area of the wick means that is heated indirectly by the wick support means to vapourize the chemical formulation into the atmosphere regardless of the orientation of the device.

Brief Description of the Drawings

Preferred embodiments of the invention will hereinafter be described, by way of example only, with reference to the accompanying drawings wherein:

Figure 1 illustrates a schematic view of separated components of a device according to a first embodiment of the present invention;

Figure 2 is a top view of the device of Figure 1 shown fitted in an engaged position;

Figure 3 is a side sectional view taken through the device of Figure 1;

Figure 4 is a schematic view of a second embodiment of the device;

Figure 5 is a schematic view of a third embodiment of the device;

Figure 6 is a side view of a fourth embodiment of the device adapted to fit a heater unit;

Figure 7 is a perspective view from above of the embodiment of Figure 6 shown separated from a heater unit which the device is adapted to engage;

Figure 8 is a perspective view from above of the device of Figure 6 shown fitted to the heater unit;

Figure 9 is a side view of the device fitted to the heater unit in Figure 8 with a portion of the heater unit removed for clarity; and

Figure 10 is an enlarged view of the joining of a shell of the chemical formulation storage means to a substrate.

Detailed Description of the Preferred Embodiments

With reference to Figure 1 there is shown a device divided into its respective components, that enables a chemical formulation, such as an insecticide or a fragrance, to be delivered to a particular site via a wicking arrangement. Although the device shown in Figure 1 includes a first portion and second portion affixable to one another, it is to be noted that an alternative singular construction (one piece) for a wick support means may be used, such as a container made by an injection moulding process. Specifically there is shown a first portion 1, which is substantially planar and formed of a suitable material, such as PET (polyethylene terephthalate). The first portion 1 has a pair of indentations or notches 12 for the purposes of correctly locating the device and more particularly to locate an aperture 13 and aperture 7 over a heater means in the form of a microheater element 10 (see Figure 3). Each of the notches 12 are designed to interact with a corresponding pair of projections (or lugs) 15 formed in a housing into which this device fits in such a manner that the interaction between the lugs and the notches are an interference fit. This provides an indication to the user, in a tactile manner, that the devices are correctly engaged in the corresponding housing.

A second portion or top portion 5 is similarly made from PET and preferably has formed therein a blister or indentation 6 which forms a reservoir for housing the chemical formulation. The portion 5 similarly has an aperture 7 and indentations or notches 16 designed to interact with corresponding projections or lugs 17, in a similar interference fit to the notches and lugs associated with the base portion or first portion 1. Both the portions 1 and 5 are designed to be joined or sealed together by suitable bonding means such as at portions 8 shown in Figures 2 and 3. Also shown in Figure 1 is a wick 4 that has a portion therein located within the body of the reservoir 6 housing the chemical formulation and a portion co-located between the apertures 13 and 7 of

the first portion 1 and second portion 5 respectively. Thus the wick 4 has one end portion 18, with reference to Figures 2 and 3, which is immersed, particularly, in a formulation such that the solid-liquid-vapour contact angle for the formulation, wick and air is 0°, and such that the wick 4 is completely wet out by the formulation, and a second end portion 19 that is in communication with the apertures 13 and 7 and a heater means 10. Preferably, the heater means 10 is a microheater element, such as a surface mount resistor. Preferably the wick is a thin flat absorbent material that is capable of wicking the active ingredient solution from the reservoir 6 to the microheater element 10. It provides a sufficiently low lateral resistance to fluid flow such that the dried area of the wick 4 in the vicinity of the portion 19 over the microheater element 10 is re-wet by the formulation in a time that is shorter than the pulse repetition cycle which delivers pulses to the microheater element 10. Such a pulse delivery arrangement is disclosed in a co-pending British patent application number 0316381.3 to the same applicant. The wick 4 preferably has a sufficiently low transverse resistance to fluid flow such that the active ingredient held in the wick 4 can emanate as vapour from the top surface of the wick 4 through aperture 7 by migration through the wick in accordance with the timing of the applied pulses to the microheater element 10. Thus the portion 19 of the wick must be able to be wet easily to enable sufficient vapour to be dispersed into the atmosphere by the application of a pulse or series of pulses to the microheater element 10 and be thereby replaced within the time of the arrival of the next pulse that supplies current to the microheater element 10.

The wick 4 must also be sufficiently thin so that the top surface of the wick 4 can be heated sufficiently by the microheater element 10 in contact with the opposite or bottom surface of the wick 4. It generally is made of material that can withstand high temperatures generated by the microheater element 10 without disintegrating or decomposing. Furthermore the wick 4 is made of a material having sufficient thermal insulation such that thermal energy transferred from the microheater element 10 heats a small part of the wick 4 to a high temperature in order to sufficiently vapourize the chemical formulation. Suitable materials that the wick may be made from include fine papers such as butcher's paper (80 microns thick), cigarette paper (30 microns thick), or fine silk or cotton cloth (less than or equal to 100 microns in thickness) in order to achieve a sufficiently high efficiency (mg/J) for long battery life. The arrangement that supplies pulses to the microheater element 10 has power provided by a series of batteries.

The apertures 13 and 7 are primarily designed, as is clearly shown in Figure 3, to be co-located over the microheater element 10 whereby the wick 4 which is in

contact with the microheater element 10 is able to disperse the active ingredient of the chemical formulation through the apertures 13 and 7 into the surrounding atmosphere. As is shown in this figure, the sealing regions 8 in the top and bottom portions 1 and 5 are joined to each other directly to form an impermeable seal. Alternatively the top and bottom surfaces of the wick 4 may be joined to the respective surfaces of the first portion 1 and second portion 5.

The container forming the reservoir 6 for the chemical formulation preferably holds a volume of active ingredient of chemical formulation that allows suitable duration of performance, preferably one to two millilitres that will last for a few weeks to a month. It is to be understood that other volume magnitudes of active ingredients of the chemical formulation are possible depending on the particular circumstances. For example, a lower limit of volume may be as low as 20 microlitres as a consequence of the potency or concentration of the active ingredient used. The end portion of the wick 18 and a substantial portion of the wick 4 is in fact in contact with the chemical formulation in the reservoir 6 at all times and in all orientations. At the other end 19 of the wick 4 it is exposed to the atmosphere through the respective apertures 13 and 7 and is in contact with the microheater element 10 that allows the emanation of the chemical formulation into the surrounding atmosphere from either or both the surfaces of the wick 4. It is noted at a portion 20 of the reservoir 6 the first and second portions 1 and 5 are bonded but still allow protrusion of the wick 4 to the atmosphere. The overall device, including the first portion 1 and second portion 5 holds the wick 4 with sufficient rigidity so that the exposed wick portions can be located with precision onto the microheater element 10. The form factor of the device must engage with the mounting points, that is through the interference fit between the lugs and notches, such that the wick 4 is correctly located in relation to the microheater element 10. Tactile feedback is provided to the user when the device is correctly engaged within a respective housing that may be a bump, as an example, to indicate that it is correctly fitted. The reservoir 6 is preferably transparent or translucent so that the user can see how much chemical formulation is remaining and replace the reservoir 6 when empty. The particular reservoir 6 may be refilled or optionally the whole device with a new reservoir may be used and fitted into the apparatus housing the microheater element 10 and a power management circuit in accordance with co-pending British patent application number 0316381.3 to the same applicant.

Shown in Figure 4 is another embodiment of the invention, wherein as with the embodiments shown in Figures 1 to 3, the wick 4 is located between portions 1 and 5. The device in Figure 4 has no indentations adapted to interference fit with

corresponding projections but may be inserted into a receptacle which is heated by a heating device. Only the aperture 7 existing in the second or top portion 5 exists which lies above end 19 of the wick 4. However, the aperture 7 may exist in only the first portion 1 in contact with end 19 of the wick 4. The other end 18 of wick 4 is in continuous contact with the chemical formulation in reservoir 6. The wick 4 is thereby wet by the chemical formulation such that the chemical formulation travels along the wick 4 through the sealed region 21 between the reservoir 6 and the top portion 5 towards the end 19 whereby the region of the device enclosed by the dotted line 22 is heated such that the chemical formulation vapourizes and emanates through aperture 7 into the surrounding atmosphere. Thus the reservoir 6 containing the chemical formulation is not heated by the particular heating device.

With reference to Figure 5 there is shown a further embodiment in which the wick 4 is mounted transversely across the longitudinal axis of the reservoir 6, top portion 5 and bottom portion 1. The edges 23 and 24 of the wick 4 are respectively mounted flush with corresponding edges 25 and 26 of the top portion 5 (and bottom portion 1). However, the edges 23 and 24 remain exposed to the atmosphere whereas the remainder of the edges 25 and 26 of the top portion 5 remain sealed to the corresponding lower portion 1 of the device. The portions of the wick 4 exterior to the reservoir 6 apart from the edges 23 and 24 are also sealed so that no chemical formulation emanates from these areas but only through edges 23 and 24. Thus when heat is applied to the region enclosed by the dotted line 27, the chemical formulation in reservoir 6 having wet the wick 4 and subsequently moved to the edges 23 and 24, vapourizes to the surrounding atmosphere through edges 23 and 24 of the wick 4.

In a further embodiment, the wick 4 may be wholly enclosed or surrounded by the chemical formulation in the reservoir but defining a boundary or partition between the reservoir and the wick 4. The wick 4 may be supported by a wick support having such a boundary or partition preferably to keep the wick substantially rigid. Such a support and partition may be made from suitable materials such as plastic or PET. At one or more locations along the partition or boundary, the wick 4 is not sealed from the reservoir 6. Thus at those particular locations the wick 4 is wet by the chemical formulation. An aperture may be located on one or both sides of the device in communication with the wick 4 such that on heating the whole device (in the region of the wick 4 and the reservoir 6) the chemical formulation emanates through the aperture and is vapourized to the surrounding atmosphere. One particular arrangement of this embodiment is a wick in the shape of a star where the points of the star are in contact with the chemical formulation and define a substantially circular boundary between the

star-shaped wick and the reservoir of the chemical formulation. At the centre of the star is an aperture through which the chemical formulation is vapourized upon application of heat.

Thus in use the device in accordance with the embodiment described with reference to Figures 1 to 3, having a reservoir full of chemical formulation such as insecticide or a fragrance, is inserted into an opening of a corresponding apparatus, which may be portable or fixed depending on the power supply to the heater means, such that the user has tactile feedback via the interference fit between the notches 12 and 16 and the lugs 15 and 17 respectively. This indicates to the user that the apertures 7 and 13 are correctly located in substantially the same plane above the microheater element 10. The apparatus is then free for use by the user in any particular application whether as a personal device, or to be left in a room for example into which the chemical formulation is vapourized.

Using the device in accordance with the embodiments of Figures 4 and 5 or in relation to the embodiment using the star-shaped wick, the device may be inserted into a receptacle having a heating means and be heated at various intervals until the chemical formulation in the reservoir 6 is fully depleted.

With reference to Figures 6 to 9 there is shown a further embodiment of the invention. Specifically device 30 includes a reservoir 32 housing a chemical formulation to be vapourized, housing 34 and a support means or substrate 36. The device 30 is adapted to be releasably detachable from a heater unit such as that shown at 38 in Figure 7. A wick 40 is in contact with an upper layer 42 of the support 36 and extends within the housing 34 and protrudes into the reservoir 32. A pair of depressions 44 and 46 formed as part of the moulding of the housing 34 are adapted to keep pressure on the wick 40 so that it remains in contact with the layer 42 of the support 36. An aperture 48 protrudes through the top portion of the housing 34 to enable vapour resulting from the heating of the chemical formulation in the wet wick 40 into the surrounding atmosphere. The support 36 also comprises a lower layer 50.

The heater unit 38 is installed in a suitable electrical socket via the terminals 52 and 54. Either after the heater unit 38 is inserted into the electrical socket or prior to its insertion, the device or cartridge 30 is fitted to the heater unit 38 such that it appears as in Figure 8 whereby layer 50 of the support 36 is either in direct contact with an existing heater 56 in the heater unit 38 or separated from the heater plate 56 by a small air gap so that when the heater unit 38 is switched on, the support 36 is heated by convection or by direct contact with the heater plate 56. The wick 40 which is wet by the chemical formulation in reservoir 32 by capillary action is in turn heated by its

contact with support 36 whereby firstly layer 50 is heated and then layer 42 is heated prior to the wick being heated. Once a nominal temperature, such as 130°C to 140°C is reached, the chemical formulation is vapourized and dispersed into the atmosphere through aperture 48 and through the various apertures 58, 60 and 62 of the heater unit 38. Projecting downwardly from elements interspersing the apertures 60 is a flange 64 , seen more clearly in Figure 9 that is designed to provide extra pressure on any portion of the housing 34 in order to keep the wick 40 in contact with the support 36. Specifically the flange 64 may contact any part of the upper surface of the housing 34 or be situated in one of the depressions 44 or 46. This is so that it can be adaptable to provide pressure to any inserted cartridge 30 that has a variation in the number and position of depressions or apertures. It also assists in providing additional inertia against the cartridge from coming out of the heater unit 38.

The construction of the device 30 has been chosen from materials designed to withstand temperatures in excess of 130°C, be robust enough to withstand contact with organic solvents and be resistant to stretching, warping and creeping. In addition it must be resilient and flexible enough to provide easy insertion into and removal from a heater unit. A particular material chosen to make the bottom layer 50 of support 36 is crystalline PET (CPET) which is not usually selected for its efficient heat transfer properties. The thin layer 42 which is sealed or adhered to layer 50 is made from amorphous PET (APET). Both the reservoir 32 and the housing 34 are premoulded, including the depressions 44 and 46 and the aperture 48 and are placed on top of the wick 40 which is already in position abutting layer 42. The reservoir 32 is then filled with the chemical formulation and both the housing 34 and reservoir 32, which are preferably made from APET, are thermally welded to the layer 42 made also from APET. The fact that the layer 42, reservoir 32 and housing 34 are all made from the same material assists in the welding and bonding process. An additional strip of APET material 66 may be thermally welded between the reservoir 32 and housing 34 as shown transversely across the device 30 in Figure 7. The seal around the housing 34 and reservoir 30 such that it is bonded to the support 36 adds rigidity to the overall device 30 to enable it to properly engage the heating unit 38 and together with the support 36 provides the physical support for the wick 40. A particular advantage with the structure is that it provides a consistent release rate of the active chemical formulation in reservoir 32 through aperture 48.

A number of materials have been tested for the base support 36 to withstand temperatures in excess of 130°C, be robust enough to withstand contact with organic solvents and be resistant to stretching, warping and creeping. Further requirements

were that the materials be capable of welding to other plastic parts, are cheap and available in commercial volumes. Most conventional thermoplastics, such as polyethylene, polypropylene and polymethylmethacrylate, become very soft at the heater temperatures and are completely unsuitable. The thermoplastics deform, melt and/or adhere to the heater. Polycarbonate was tested and although it is a high temperature thermoformable material, it was found that thermoforming made the polycarbonate vulnerable to solvent attack. The thermoformed portions exhibited severe stress crazing in contact with a solvent.

Other known materials include KAPTON® (a registered trade mark in the name E I Du Pont De Nemours and Company) which is a polyamide material and ULTEM® (a registered trade mark in the name General Electric Company), a polyetherimide material. However these materials are too expensive to produce.

A relatively cheap material is biaxially oriented APET (bioPET) which is an APET film that has been stretched firstly in one direction (eg. x axis) and then in another direction perpendicular to the first direction (eg. y axis). This induces a high degree of polymer chain alignment and produces a very robust high temperature material. It is suitable for making oven bags. However it is only available in very thin films and these grades have no structural strength. Lamination of bioPET to a stiff card was attempted, however the resulting material was essentially a plastic coated cardboard that, although provided the required temperature and solvent resistance and weldability, the base of the material was not rigid enough. The heated area was twisted and deformed and the thermoformed upper portion was stressed.

The most suitable material tested for layer 50 was CPET, which essentially is APET into which is dispersed a finely powdered nucleating agent, such as crystalline polypropylene, together with a pigment depending on the grade. The layer 42 of APET is then laminated or bonded to one surface of the layer 50. The reason for this particular construction is that while the bulk of the plastic is amorphous, it is readily thermoformed but during thermoforming crystallization occurs rapidly due to the nature of the nucleating agent. The thermoformed portion is thus CPET with superior mechanical properties. The APET layer 42 remains untransformed and can be bonded or heat sealed to a further APET layer such as one incorporating the housing 34 and reservoir 32. Grades of CPET material tested include 750 micron.

The initial layer of APET that is thermoformed to produce the reservoir 32 and housing 34 has less stringent requirements. The temperature used for thermoforming is much lower than that used for support 36 as the upper portion containing the reservoir 32 and housing 34 is not in direct contact with heater plate 56.

When the amount of chemical formulation remaining in the reservoir 32 is very low and the device 30 is oriented as a result of the orientation of the electrical socket or heater unit 38, the welding of the upper shell 70 of the reservoir 32 to the layer 42 is such that the residual amount of chemical formulation 68 rises by virtue of capillary action. Thus near the join or edge 72 of the shell 70 to layer 42 the gap 74 created by such a join allows the residual chemical formulation 68 to travel up the sides of the reservoir 32, effectively normal to the page of Figure 10. This provides a substantial advantage in that the wick 40 need not protrude fully into the reservoir 32. By being in contact with an upper surface 76 of the reservoir 32 adjacent where it joins the layer 42 means that the advancing residual chemical formulation 68 may reach the end of the wick 40 and thereby provide additional chemical formulation to be vapourized.

Alternatively, the wick 40 may extend into the reservoir 32 specifically in contact with the edge or join 72 or otherwise positioned in the gap 74, preferably along the entire periphery of the join 72. This enables a capillary action through the wick 40 to take place when the amount of formulation in the reservoir 32 is low and regardless of the orientation of the device 30 or heating unit 38 receiving the device 30.

With reference to Figure 9 it is seen that the support 36 is flexible enough to bend at a location 80 in order to fit within the heater unit 38 and therefore make contact or be in close vicinity of the heating mat 56. Alternatively a step may be provided in the support 36 between the reservoir 32 and the housing 34 to facilitate easy insertion and removal of the device 30 to the heater unit 38. Alternatively there may be a step down or step up provided inside the heater unit 38 cooperating with the step in the support 36.

The housing 34 of the device 30 is specifically shaped and moulded to fit and be retained by the heater unit 38. The flange 64 also additionally assists in retaining the housing 34 and pressing the wick 40 against the layer 42. The step down arrangement from the reservoir 32 in the layer 36 provides a flexible strip that can be fitted to an increased range of existing heating units. ..

The wick may be made from a suitable material as previously mentioned in relation to the first embodiment and generally the refill or chemical formulation in reservoir 32 will last between seven and fourteen nights in a single room. Once a cartridge or device 30 has been expelled of its chemical formulation it would be a simple matter of inserting a refill or new cartridge into the heater unit 38 to set off a new seven to fourteen night period of use. It is noted that the reservoir 32 protrudes from the heater unit 38 so that the user can easily identify how much chemical formulation is left.